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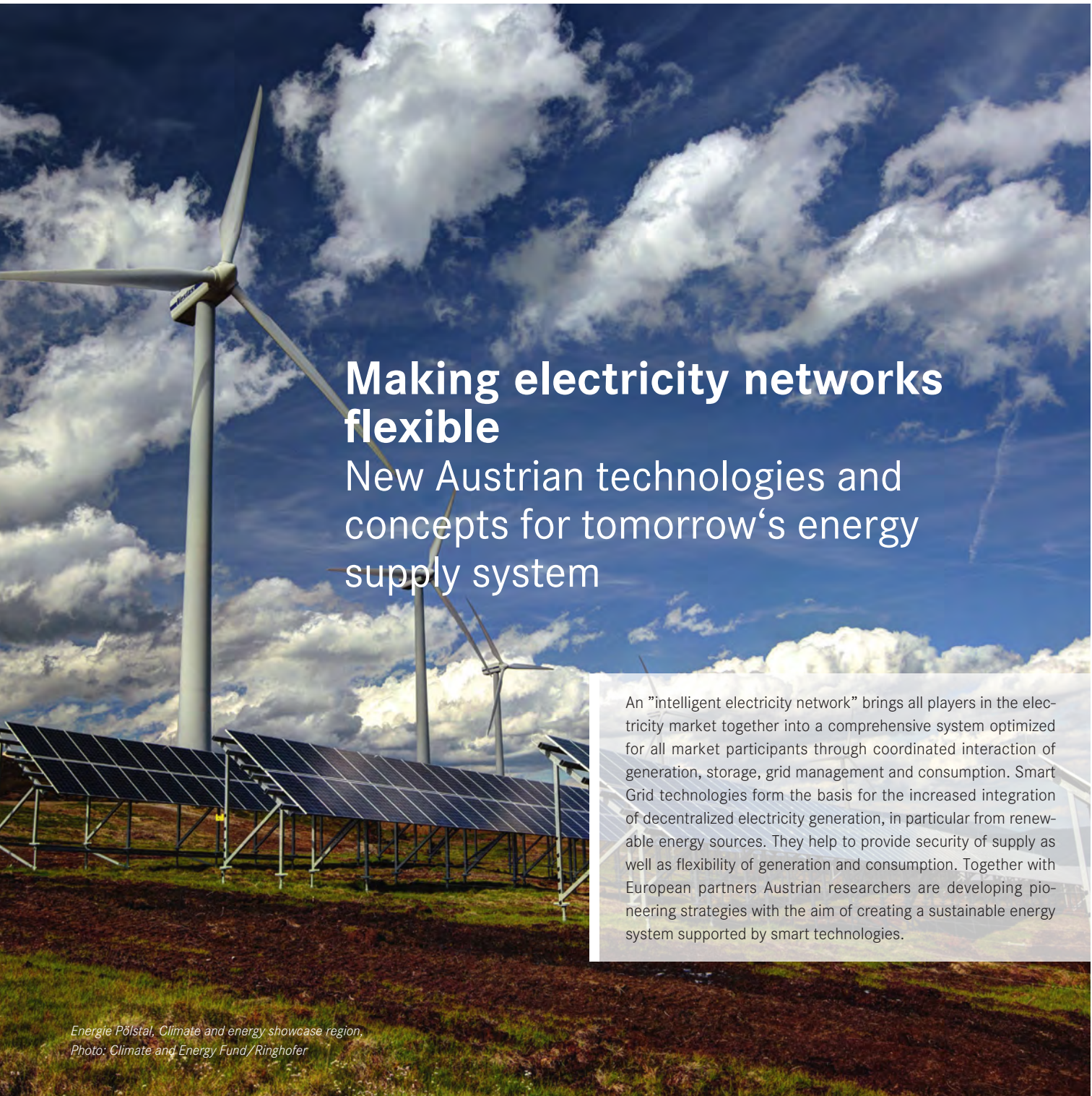
Current developments and examples of sustainable energy technologies



Making electricity networks flexible

New Austrian technologies and concepts for tomorrow‘s energy supply system

An ”intelligent electricity network” brings all players in the electricity market together into a comprehensive system optimized for all market participants through coordinated interaction of generation, storage, grid management and consumption. Smart Grid technologies form the basis for the increased integration of decentralized electricity generation, in particular from renewable energy sources. They help to provide security of supply as well as flexibility of generation and consumption. Together with European partners Austrian researchers are developing pioneering strategies with the aim of creating a sustainable energy system supported by smart technologies.

Energie Pölstal, Climate and energy showcase region.
Photo: Climate and Energy Fund/Ringhofer

Smart Grid technologies
Part of the sustainable integrated energy system

The massive expansion of solar power, biomass, wind energy and hydropower will lead to decentralized energy generation and weather-dependent fluctuations in electricity supply. An increasing number of small generation facilities spread across the landscape feed electricity into existing networks, presenting a great challenge for grid management.

Photos: Climate and Energy Fund/Ringhofer

Energy supply and demand need to be coordinated and optimized through intelligent management and crosslinking. Network operators will become managers of the energy system; many enterprises and households will consume and generate electricity simultaneously, i.e. become "prosumers". Alongside intelligent grid control, the energy consumption of industry, buildings, electric vehicles and households must be flexibly and efficiently organized.

Smart Grid technologies – together with flexible components and information and communication technologies – create the technical basis for intelligent electricity networks which connect all energy system actors (generators, storage devices and consumers) and make optimized interaction feasible.

In order to be able to make use of Smart Grid technologies to a significant extent it is necessary to push on with international standardization and to intensify transnational cooperation. In the "European Strategic Energy Technology Plan" (SET Plan) integrating renewable energy sources into power networks is a key issue, which is being developed further internationally, amongst other things, within the "European Electricity Grid Initiative" (EEGI). For years Austria has made contributions towards the European goals in the shape of R&D activities. In programmes funded by the Austrian Ministry for Transport, Innovation and Technology (BMVIT) and the Austrian Climate and Energy Fund, technologies and strategies have been developed and implemented as part of demonstration projects in Austrian Smart Grid model regions.

The Smart Grids 2.0 strategy process, initiated by the BMVIT, actively supports the further development of power supply systems in collaboration with experts from electricity companies, industry and research. The aim is to evaluate the results thus far from research and implementation jointly, and to develop medium-term strategies from that and hands-on action plans for Austria. The process focuses on: developing a Technology Roadmap for Smart Grids in and from Austria (responsible Technology Platform Smart Grids Austria), holding a series of expert workshops (BMVIT / B.A.U.M.) and working out a Strategic Research Agenda with 2035 as a timeframe (AIT Austrian Institute of Technology).

In future the focus will have to be on embedding Smart Grid solutions in an integrated energy system which meets the requirements of markets, customers and grids. The special solutions already developed (e.g. for active distribution networks, electric vehicles, load and demand side management) must be brought together based on the results so far. The Austrian projects presented here, partly conducted in collaboration with international partners, show some new research approaches for integrating Smart Grid technologies in an energy system suitable for the future. ◘

ECONGRID –
macroeconomic effects of Smart Grids

The Institute for Higher Studies Carinthia (IHSK) has, initiated by the Austrian Climate and Energy Fund, conducted a macroeconomic evaluation of the smart expansion of Austria's power supply system. The costs and advantages of a conventional and a smart development track were compared by means of three projected scenarios (with variations regarding the share of decentralized renewable energy generation and demand flexibility). From these the picture emerged that the volume of investment in the distribution network would be considerably lower should the smart modernization option be chosen. The most advantageous overall effects show up in the scenario "Flexdemand", which was calculated on the assumption of high load-redistribution flexibility and a high degree of energy self-sufficiency at the customer end.
www.carinthia.ihs.ac.at/econgrid/econgrid.html

Photo: Climate and Energy Fund/Ringhofer

hybrid-VPP4DSO
Comprehensive plan for virtual power plants in European markets

In the course of various EU research projects the first few market-driven approaches for virtual power plants have been developed, focussing on trading in selected energy markets. These Virtual Power Plants (VPPs) make use of curtailing aggregated loads, distributed generators and stand-by generation capacities (e.g. back-up power supplies) as resources for services which can be traded in European energy markets. On the other hand there are concepts for technical or grid-driven virtual power plants, where loads and electricity generation are controlled to keep the parameters of the distribution grid within the permitted limits and thus improve security of supply. In most European countries these approaches cannot yet be implemented as successful business models within existing regulatory frameworks.

Researchers at AIT Austrian Institute of Technology are currently developing a concept for a virtual power plant that combines both grid-driven and market-driven approaches. The *hybrid*VPP merges the advantages of economic and technical VPP solutions into a comprehensive concept. The aim is both to ensure the secure distribution network operation even during massive demand-response activity and to improve the economic viability of technical demand-response solutions for distribution network operation.

The project *hybrid*-VPP4DSO involves the simulation-based evaluation of operating a virtual power plant as regards impact on the network, the technical-economic simulation of demand-response aggregation and the simulation of suitable business models. Every area of the distribution network is graded in real time in categories ranging from ”not critical” to ”very critical”. In addition, the network operator may request switching measures from the *hybridVPP*. From this input the *hybrid*VPP calculates possible switching options based on short-term requirements from network operation and electricity trading, and determines the least costly option. Requirements from network operation have priority over those from electricity trading.

After a technical proof-of-concept laboratory test run, the approach is to be tested in actual grid sectors in Slovenia (ELEKTRO LJUBLJANA) and Austria (Stromnetz Steiermark GmbH). The test is coordinated by AIT Austrian Institute of Technology. STEWEAG-STEG GmbH, Elektro energija (Slovenia), Vienna University of Technology - Energy Economics Group, Institute for Energy Systems and Electrical Drives, Jan W. Bleyl, cyberGRID and the Graz Energy Agency are also partners in this project. On top of this, the *hybrid*VPP concept affords the possibility of adapting the business model to country-specific regulatory requirements in various European states. ◘

>> Austria takes part in the EU project eBADGE (AIT Austrian Institute of Technology, Austria Power Grid – APG, cyberGRID and Vienna University of Technology) in which the national power balancing markets in Austria, Italy and Slovenia are being analysed and risks, opportunities and changes in connection with trans-border exchange are being assessed.
www.ebadge-fp7.eu/project-news
(Interface intended in *hybrid*-VPP4DSO)

Further EU projects focusing on VPPs:
www.evolvdso.eu
(Interface intended in *hybrid*-VPP4DSO)
www.fenix-project.org
(Focus VPP – similar to *hybrid*-VPP4DSO)
www.smart-a.org
(Focus Demand Response)

Photo © Renate Trummer, Fotogenia.at

The customer value of hybrid Smart Grids

“Particularly in urban areas, coupling the grids for electricity, gas and district heating with pioneering technologies locally makes the entire system much more flexible and resilient: just right for core customer needs as regards comfort and security of supply. And providing more local customer-oriented service by means of renewable sources of energy is clearly in line with the overall trend toward sustainability. Together with our project partners we are demonstrating this within the framework of Smart City Graz.“ ***www.smartcitygraz.at***

Mathias Schaffer, Energie Steiermark AG

Load dispatching center, Salzburg AG; Photo: Andreas Hechenberger

SGMS – Integra
Model for grid-driven and market-driven operation of Smart Grids

The Smart Grid model region Salzburg (SGMS) is the first area in Austria where innovative technologies and solutions from various fields of Smart Grid implementation are systematically brought together. In order to make use of potential synergies and to ensure the secure operation of the network, it is necessary to embed the specific pilot applications (e.g. integrating renewable energy into distribution networks, building integration, households and electric vehicles, also making loads more flexible in business and industry) in a comprehensive system. At the same time market and grid requirements have to be coordinated.

So far partial solutions have been considered independent from each other, and the requirement of system interoperability has not been taken into sufficient account, which is why, for example, in the field of ICT various protocols and interfaces compete with each other. This is where the INTEGRA project steps in, conducted by Salzburg AG in collaboration with Siemens AG Österreich, AIT Austrian Institute of Technology, the Vienna University of Technology and the German OFFIS – Institute for Information Technology.

On the basis of the results so far from the Smart Grid model region Salzburg an internationally standardized Smart Grid reference architecture is to be developed, making it possible to bring local intelligent distribution networks and transregional virtual power plants in line with demands from European energy markets, while satisfying security and privacy guidelines at the same time. To justify the claim to international status, the project is being conducted in cooperation with the German partner project In2VPP. www.in2vpp.de

The focus is on how to organize secure and stable operation of the electricity system while Smart Grid services influencing and depending on each other are part of the equation.

Aided by known tools from other areas, such as Model Driven Architecture (MDA), a comprehensive picture of the existing partial Smart Grid solutions is systematically assembled in the course of the project and investigated with respect to the entire energy system.

In order to bridge “missing links”, i.e. gaps in the transfer of data within the Smart Grid regarding the requirements of the market, customers and the network, a so-called ”Flexibility Operator” (i.e. a configurable data distribution platform with integrated business logic) is to be developed and tested in the model region Salzburg. Aided by modular tools, such as interfaces and software modules, individual systems are to be made interoperable. ◘

Energy policy turnaround = renewables + energy efficiency + smart grids

“In future the grid operator will acquire a new role; as a higher share of power generated comes from renewables (sun, wind), which are weather-dependent, there will be a good deal of unavoidable fluctuation. The key question is therefore how to maintain the electricity grid in a stable state in spite of fluctuations in generation and variations in demand. Supply and demand must be coordinated (balanced) by means of intelligent management and cross-linking. The grid operator thus develops from a power distributor pure and simple to a system manager.“

Michael Strebl, CEO Salzburg Netz GmbH

Photo © Doris Wild, wildbild

Model region Salzburg, Photo: wildbild.at

electrodrive, Salzburg AG, Photo: Andreas Hechenberger

Smart Grid model region Salzburg

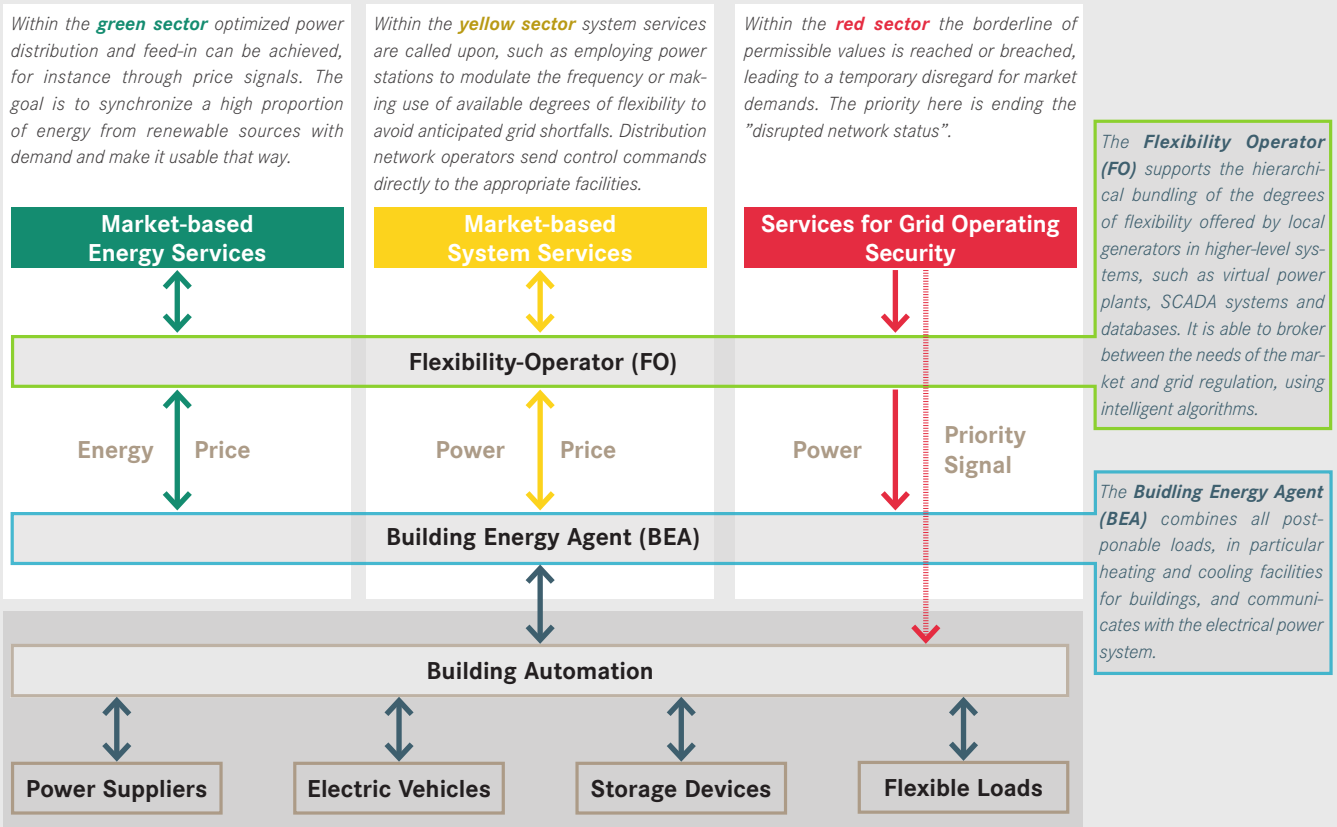
The Smart Grid model region Salzburg (SGMS) encompasses a total of 23 projects largely funded by the Austrian Ministry for Transport, Innovation and Technology and the Climate and Energy Fund. Pioneering solutions for active distribution network operation are implemented and evaluated in the course of demonstration projects (currently in the medium-voltage grid in Lungau, in the Smart Grid model community Köstendorf and in the residential scheme Rosa Zukunft in Salzburg Taxham) in actual grid sectors.

Apart from technological development, there is special emphasis on analysing customer behaviour and acceptance. The aim is to implement "Smart Infrastructure Salzburg", an intelligently acting energy system which matches electricity generation and consumption, taking into account regional differences, thus making a high share of volatile renewable energy input viable and avoiding grid congestions. Smart Grid technologies are utilized for intelligent network control as well as exercising control over flexible loads and storage facilities in industry, buildings and electric vehicles.

www.smartgridssalzburg.at

Network and market conditions in Smart Grids

The diagram shows various states of the electricity market resulting from particular network scenarios. Depending on the state of the grid various different energy or system services will be needed in order to keep the entire system functioning normally, so that the market can operate without restrictions. Ideally access to these services would be automated.



Pioneering control strategies
for a flexible, secure power supply

The modernization of traditional distribution network layouts offers the opportunity to improve the flexibility and supply security of power networks by adopting new control strategies. The implementation of ICT, combined with active operation facilities, electric vehicles and stationary storage devices, make it possible to automate network operation increasingly and to influence specific generation units and consumers. At the Vienna University of Technology (Institute of Energy Systems and Electrical Drives) research is being conducted on innovative control methods capable of maintaining a flexible and secure power supply.

Photo: Climate and Energy Fund/Ringhofer

Photo: Jürgen Fälchle - Fotolia.com

"We research Smart Grid technologies to improve the hosting capacity of our power supply systems for local renewable energy sources as far as possible without costly network expansion. In the future these technologies will also contribute to securing the high reliability of our power supply."

Wolfgang Gawlik
Vienna University of Technology
Institute of Energy Systems and Electrical Drives (ESEA)

In the **SORGLOS** project researchers are developing methods and algorithms to achieve blackout robustness in individual network sectors (microgrids) via existing local producers and storage devices and by means of installed Smart Grid technologies. The research goes into black-start capability, secure network decoupling during blackouts, regulating generation, influencing loads, managing storage devices, and support during network reactivation.

Representative rural and urban Smart Grid network sectors with their differing characteristic generation structures form the basis. First of all, individual components of the networks under examination are modelled. In the case of the rural medium-voltage network a pumped-storage power plant with a Francis turbine is emulated, to provide power during an outage. For the small-town low-voltage network with no access to additional power plants a dynamic model of a backup diesel generator, to ensure supply security, is constructed.

The functioning of the algorithms developed is simulated in a virtual demonstration with real data from Austrian Smart Grid projects (Great Walser Valley/Vorarlberg and Eberstalzell/Upper Austria).

Within the framework of the **aDSM – Active Demand-Side-Management through Feed-In Forecasting** hierarchically scalable systems with distributed intelligence are being developed, to bring the consumption of households and electric vehicles in line with the power fed in by inhouse photovoltaic equipment as efficiently and flexibly as possible. Load redistribution or controlled charging activities are processed actively and looking ahead, aided by an optimized feed-in forecast. A model settlement with 126 households and a high proportion of renewable energy (photovoltaics) provides the basic data, showing a representative cross-section of building and residential conditions at the low-voltage level.

Through the control algorithm demand from individual households is regulated or postponed. Electro-thermal consumption (electric heating, circulation pumps, water boilers, fridges and freezers) can be timed flexibly while staying within a time limit for power cutoff. Electric-vehicle batteries with state of charge more than 50 % are recharged under a controlled regime. For washing machines, tumble-dryers and dishwashers there are specific programmes on hand in which the starting time can be delayed. If demand cannot be satisfied at the local level, higher system levels (up to the transmission grid) or energy storage devices should intervene in a coordinated fashion.

Photo: Climate and Energy Fund/Ringhofer

The results show that the local aDSM approach increases the ratio of solar electricity consumed internally to that generated and the degree of self-sufficiency (i.e. the ratio of solar electricity consumed internally to overall electricity consumption) of households, and reduces actual average expenditure on electricity in households. In comparison with uninfluenced consumption patterns the share consumed internally can be increased from 20 % to 28 %, the degree of self-sufficiency from 24 % to 35 %. The decisive factors contributing to this outcome are the scale of the photovoltaic equipment and the use of electric vehicles. ◘

Photo: Kzenon - Fotolia.com

Photo: Eisenhans - Fotolia.com

Photo: Climate and Energy Fund /Ringhofer

ProAktivNetz
Automated planning of active distribution grid operation

KNG-Kärnten Netz GmbH's **ProAktivNetz** project researches how to integrate renewable energy sources (photovoltaics, wind and hydropower) under all circumstances (e.g. maintainance work or occasional disruptions) which might occur during real network operation.

The power feed-in of renewable local generators is directly dependent on local weather conditions (amount of wind, sunshine and water). The distribution network operator must be able to anticipate how much power these generators will supply, and switch the grid at the appropriate time, so as to deliver power to customers within a guaranteed voltage band at all times and keep the distribution grid within its limits.

The aim of the ProAktivNetz project is to ensure security of supply and a maximum of renewable energy integration in any operating situation, by means of automated solutions. The project is being implemented in cooperation with AIT Austrian Institute of Technology, the Vienna University of Technology and the industry partners Siemens and Ubimet.

In the course of the project an algorithm for optimized active operation of distribution networks will be developed and tested, taking into account the current and forecasted behaviour of local electricity generation (mainly from renewable sources).

For the first time the cross-links and interactions between individual influencing factors are analysed in detail and solutions worked out to make automated planning possible for a defined time frame (48 hours). Timetables and generation anticipated from local generators, plans for disconnections due to maintenance work and disruptions occuring in the distribution grid are used for the calculations.

ProAktivNetz will lay the groundwork for operating future active distribution networks with an optimized schedule which reconfigures the network by switching, in line with the demand and generation situation anticipated. Building on the project's findings, it will be possible to develop appropriate industrial products for use in distribution networks. ◘

Angela Berger, CEO
Technology Platform
Smart Grids Austria

Opportunities and perspectives for Smart Grid technologies from Austria

In recent years Austria has invested a lot in researching, developing and demonstrating Smart Grid technologies. How successful have these activities been so far?

By now Austria has three large Smart Grid model regions in Salzburg, Upper Austria and Vorarlberg; in each region different aspects are tested and researched into, such as the intelligent integration of customers into the network, active operation of distribution networks, ICT for Smart Grids or integrating small photovoltaic units into the grid efficiently. These are all internationally recognized demo projects and a great success for our activities so far. The model region Salzburg was even awarded the Core Label by the European Electricity Grid Initiative in 2013, and thus recognized as a European lighthouse project.

How does Austria fare in the technological field of Smart Grids in an international comparison?

Austria has already taken up position early, e.g. by founding the Technology Platform Smart Grids Austria, which does an excellent networking job in Austria among the relevant players from industry, electricity companies and R&D organizations. During the last few years a lot of R&D funding went into developing intelligent electricity networks. As a result, Austria is by now right at the forefront of the European SET Plan Initiative for power grids. Within the D-A-CH cooperation setup, experience with model projects is swapped between Austria, Germany and Switzerland. In addition experts from Austria have worldwide contacts with top institutions (e.g. from the USA and Korea) through the "International Smart Grids Action Network" (ISGAN).

What are the next steps on the path towards a sustainable power supply system?

The electricity grids have to be upgraded to meet higher challenges, e.g. of integrating local electricity generators. That is how security of supply can be ensured in future, too. Intelligent solutions expand the capability of grids. Smart Grids make it possible to pursue a conventional network expansion very selectively and efficiently. As they are not just a single technology, but need to be developed and tested according to regional network requirements, it is still necessary to provide targeted and transparent funding for Smart Grid technologies and to implement further large-scale demonstration projects. This is essential if we want to maintain and expand Austria´s pioneering role in integrating renewable energy sources and in load management.

energy innovation austria presents current Austrian developments and results from research work in the field of foward-looking energy technologies. The content is based on research projects funded by the Austrian Federal Ministry for Transport, Innovation and Technology and the Climate and Energy Fund. **www.nachhaltigwirtschaften.at** **www.klimafonds.gv.at**

INFORMATION

SGMS – Integra
Salzburg Netz GmbH
Contact: Robert Priewasser
Robert.Priewasser@salzburgnetz.at
www.smardgridssalzburg.at

hybrid-VPP4DSO
AIT Austrian Institute of Technology GmbH
Energy Department
Contact: Michaela Jungbauer
Marketing and Communications
michaela.jungbauer@ait.ac.at
www.ait.ac.at

aDSM & Sorglos
Vienna University of Technology
Institute of Energy Systems and Electrical Drives (ESEA)
Contact: Christoph Maier
maier@ea.tuwien.ac.at
www.ea.tuwien.ac.at

ProAktivNetz
KNG-Kärnten Netz GmbH
Contact: Reinhard Iskra
reinhard.iskra@kaerntennetz.at
www.kaerntennetz.at

Technology Platform Smart Grids Austria
Contact: Angela Berger
angela.berger@smartgrids.at
www.smartgrids.at

Information about the Austrian Smart Grids Model Regions and Projects:
www.energiesystemederzukunft.at/highlights/smartgrids

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For change of your shipping address contact: versand@projektfabrik.at